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Critical metals and minerals of Kazakhstan and other central Asian countries: institutional barriers and strategic export policy

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ABSTRACT

Relevance. Central Asia holds vast reserves of critical metals and minerals such as lithium, nickel, aluminum, copper, uranium, and rare earth elements, offering strong potential for integration into global value chains. However, its resource-dependent export model and institutional barriers hinder investment and industrial processing. Kazakhstan, with the region's largest resource base, plays a key role in shaping its critical metals and minerals strategy.

Objective. The study aims to develop an evidence-based strategic framework for Kazakhstan's export policy in critical metals and minerals, taking into account other Central Asian countries. It relies on comparative analysis, institutional assessment, and scenario-based forecasting.

Methods and Data. The methodology combines time-series analysis of export dynamics using data from international trade databases (UN Comtrade and ITC Trade Map), forecasting for 2025–2027, a comparative institutional analysis of the models of Australia, Chile, and Kazakhstan, as well as an evaluation of regulatory quality based on international indices and analytical sources.

Results. Modeling indicates a steady rise in Central Asian exports to Europe and Asia but also highlights structural imbalances and institutional barriers that hinder a transition from a resource-based model to sustainable development. Using Kazakhstan as a case study, the study proposes a framework emphasizing deeper processing, export diversification, and integration of environmental, social, and governance (ESG) standards.

Conclusions. Central Asia holds strong potential to contribute to the global energy transition, with Kazakhstan best positioned to lead a long-term export strategy. The proposed framework combines national and regional perspectives to foster industrialization, attract investment, and strengthen the region's role in the global economy.

KEYWORDS

critical metals and minerals, rare earth metals, Central Asia, export policy, institutional barriers, sustainable development, resources, investments

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Критически важные металлы и минералы Казахстана и других стран Центральной Азии: институциональные барьеры и стратегическая экспортная политика

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АННОТАЦИЯ

Актуальность. Центральная Азия располагает значительными запасами критически важных металлов и минералов, включая литий, никель, алюминий, медь, уран и редкоземельные элементы, что создаёт потенциал для интеграции в глобальные цепочки добавленной стоимости. Экспортная модель региона при этом сохраняет сырьевую направленность и институциональные барьеры, ограничивающие приток инвестиций и развитие переработки. Казахстан, обладая крупнейшей ресурсной базой, выступает естественным центром формирования региональной стратегии в сфере критически важных металлов и минералов, от успеха которой зависит и региональная динамика.

Цель исследования — формирование научно обоснованной стратегической основы экспортной политики в сфере критически важных металлов и минералов для Казахстана с учётом положения других стран Центральной Азии, на основе сравнительного анализа международных практик, а также институциональной оценки и сценарного прогнозирования.

Методология и данные. Методология опирается на анализ временных рядов экспортной динамики по данным международных торговых баз UN Comtrade и ITC Trade Map, прогнозирование на 2025–2027 годы, сравнительно-институциональное исследование моделей Австралии, Чили и Казахстана, а также оценку качества регулирования по международным индексам и аналитическим источникам.

Результаты. Математическое моделирование показало устойчивый рост экспортных потоков стран Центральной Азии в направлении Европы и Азии, при этом выявлены структурные диспропорции и институциональные ограничения, препятствующие переходу от сырьевой модели к модели устойчивого развития. На примере Казахстана разработана стратегическая рамка, включающая углубление переработки, диверсификацию экспортных направлений и внедрение стандартов экологической, социальной и корпоративной ответственности.

Выводы. Центральная Азия обладает значительным потенциалом участия в глобальном энергетическом переходе, однако именно Казахстан способен сыграть ключевую роль в формировании долгосрочной экспортной стратегии. Предложенная стратегическая рамка обеспечивает сочетание национального и регионального уровней, создавая предпосылки для индустриализации, привлечения инвестиций и укрепления позиций региона в мировой экономике.

КЛЮЧЕВЫЕ СЛОВА

критически важные металлы и минералы, редкоземельные металлы, Центральная Азия, экспортная политика, институциональные барьеры, устойчивое развитие, ресурсы, инвестиции.

БЛАГОДАРНОСТИ

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ДЛЯ ЦИТИРОВАНИЯ

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哈萨克斯坦及中亚其他国家关键金属与矿物：制度壁垒与战略性出口政策

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摘要
现实性：中亚拥有丰富的关键金属和矿产资源，包括锂、镍、铝、铜、铀和稀土元素，具备融入全球价值链的潜力。然而，该地区的出口模式仍以原材料为导向，且存在制度性障碍，限制了投资流入和加工业发展。哈萨克斯坦拥有最大的资源基础，是制定区域关键金属和矿产战略的天然枢纽，该战略的成败将决定区域格局。
研究目标：结合其他中亚国家的实际情况，通过对国际实践的比较分析、制度评估和情景预测，为哈萨克斯坦关键金属和矿产领域的出口政策制定科学的战略框架。
数据与方法：该方法基于对联合国商品贸易统计数据库和国际贸易中心贸易地图中出口动态时间序列数据的分析，对2025–2027年进行预测，对澳大利亚、智利和哈萨克斯坦的模式进行比较制度研究，并基于国际指数和分析来源对监管质量进行评估。
研究结果：数学建模显示，中亚国家对欧洲和亚洲的出口流量呈稳定增长态势，同时揭示了阻碍从资源型模式向可持续发展模式转型的结构性失衡和制度性制约因素。以哈萨克斯坦为例，本文构建了一个战略框架，包括深化加工、出口方向多样化以及实施环境、社会和企业责任标准。
结论：中亚地区在全球能源转型中拥有巨大潜力，而哈萨克斯坦尤其能够在制定长期出口战略方面发挥关键作用。拟议的战略框架连接了国家和区域层面，为工业化进程、投资吸引及巩固该地区在全球经济中的地位奠定了基础。

关键词
关键金属和矿产、稀土金属、中亚、出口政策、体制壁垒、可持续发展、资源、投资

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Introduction

Technological development and the accelerating shift toward low-carbon energy are driving unprecedented demand for critical metals and minerals (CMMs). Modern technologies, including electric vehicles, batteries, solar panels, wind turbines, microelectronics, and telecommunications, rely heavily on lithium, nickel, cobalt, copper, aluminum, and rare earth elements. These resources are becoming the backbone of the digital and "green" transformation of the global economy.

This study addresses the following question: under what institutional and strategic conditions can the countries of Central Asia, particularly Kazakhstan, leverage their critical metals and minerals (CMM) resources to transition from raw-export dependence to sustainable participation in global value chains? In other words, our task is to identify an export policy framework that would enable the rising global demand for CMMs to generate long-term competitive advantages and modernization drivers, rather than fueling another cycle of "resource volatility."

According to the International Energy Agency, between 2017 and 2022, global demand for lithium tripled, cobalt consumption rose by 70 %, nickel by 40 %, and the overall market reached 320 billion USD[1]. The high concentration of production in a few countries, primarily China, has increased dependency risks (Mancheri et al., 2019). This concentration has made Western economies strategically vulnerable, prompting intensified efforts to diversify supply sources (Kowalski & Legendre, 2023). In response, the USA and the EU have adopted national strategies that encourage domestic production, foster international alliances, and pursue forms of "resource nationalism", including control over foreign extraction, to reduce dependence on China. (Xu, 2024; Zakirov, 2025). Against this backdrop, mineral-rich regions, including Central Asia, have come into focus as potential new nodes in global supply chains.

Central Asia holds substantial reserves of uranium, lithium, aluminum, copper, chromium,

[1] International Energy Agency. (2023). *Critical minerals market review 2023.* Paris: IEA. https://www.iea.org/reports/critical-minerals-market-review-2023 (date of access: 13.05.2025)

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manganese, zinc, and rare earth elements (Guseinov & Sultonazarov, 2024). Collectively, the five countries of the region account for roughly 39 % of global manganese ore reserves, 30 % of chromium, 20 % of lead, and 12–13 % of zinc, as well as significant shares of titanium, uranium, and rare metals[2]. This highlights the region's strong strategic potential in the critical metals and minerals sector — a potential that calls for a carefully designed export policy. According to the US Geological Survey, at least 384 deposits and occurrences of rare and rare-earth metals[3] have been identified across Central Asia, confirming its status as a promising supplier of strategic raw materials for the global energy transition (Issatayeva et al., 2024). In several countries of the region, export revenues from metals already equal or surpass more traditional export categories. In Kazakhstan, copper export revenues exceeded those from natural gas for the first time in 2020, while in Uzbekistan, critical minerals, primarily copper and zinc, accounted for over 11 % of total exports (Zakirov, 2025). However, resource abundance alone does not create added value. Without domestic processing capacity, predictable regulatory frameworks, and diversified sales channels, the region risks remaining locked into the role of a supplier of semi-finished materials.

The wealth of CMMs offers the countries of Central Asia unique opportunities. On the one hand, it enables them to diversify resource-dependent economies traditionally focused on oil, gas, gold, and cotton by entering the rapidly expanding market for high-tech raw materials (Rao, 2024). For Kazakhstan and Uzbekistan, critical metals could become new "growth points," reducing dependence on hydrocarbons and gold while securing a new niche in global value chains (Issatayeva et al., 2024). This potential is reinforced by geography: Central Asia borders China and is close to major markets in Europe and South Asia, which simplifies export logistics. Concrete steps toward integration into global value chains are already underway. Between 2022 and 2024, the EU signed strategic partnerships with Kazakhstan and Uzbekistan on critical raw materials, including joint "roadmaps" for industry development. Meanwhile, the USA launched the C5+1 Critical Minerals Dialogue, expressing its readiness to invest in mining and processing rare metals in Central Asia in cooperation with local governments. These initiatives reflect the West's growing interest in using the region's resources to diversify global supply chains and offset China's monopoly. This situation creates a fundamental crossroads: external initiatives provide a window of opportunity, but their success ultimately depends on domestic institutions, more specifically, the quality of mining regulation, ESG compliance, processing depth, and logistical connectivity.

On the other hand, Central Asian countries face a difficult challenge: how to convert growing global demand for CMMs into long-term development while avoiding the traps of resource dependence and environmental degradation. International experts warn that simply expanding extraction without proper governance may deepen existing structural imbalances, increase vulnerability to global price fluctuations, and cause damage to the environment (Kowalski & Legendre, 2023). The global experience of the "resource curse" shows that inflows of raw-material revenues, if not properly managed, can lead to stagnation in non-resource sectors and institutional distortions (Sachs & Warner, 2001). For Central Asian countries, which already struggle with limited diversification, weak institutions, and ecological challenges, the risk of repeating this trajectory is very real (Pomfret, 2019). The key strategic question, then, is whether investments in CMMs can drive sustainable growth or deepen the region's dependence on raw materials. To meet this challenge, export policy must reduce revenue volatility, stimulate local processing, and comply with environmental requirements.

Kazakhstan, Uzbekistan, Tajikistan, and Kyrgyzstan are seen as promising suppliers of critical resources for the global energy transition — a perception reinforced by growing interest from the European Union, the United States, and China (Zhiyenbayev, 2025). However, the region's export model remains largely resource-based as low processing depth and limited market diversification

[2] Caspian Policy Centre. (2024, February 23). *The C5+1 Critical Mineral Dialogue: What It Means and How We Got Here*. Caspian Policy. Retrieved from: https://www.caspianpolicy.org/research/central-asia/the-c51-critical-mineral-dialogue-what-it-means-and-how-we-got-here/ (date of access: 13.03.2025)

[3] USGS (United States Geological Survey). *(2016).* Rare Earth Element (REE) and Rare Metal occurrences in Central *Asia: Inventory [Data set]*. U. S. Geological Survey. Retrieved from: https://data.usgs.gov/datacatalog/data/USGS:595a5be7e4b0d1f9f052831d (date of access: 13.05.2025)

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continue to hinder integration into global value chains[4]. This gap between resource endowment and institutional readiness defines the core focus of this study.

The main obstacles are institutional and structural. Limited transparency in subsoil regulation, low integration of ESG standards, and insufficient processing capacity constrain a sustainable export policy. According to Ernst & Young (2023), geopolitics, sustainability requirements, and supply security represent the key global risks for the mining industry. For Central Asian countries, these challenges are further compounded by social and environmental imbalances and dependence on a single external market.

In this context, Kazakhstan, with its vast resource base and stronger institutional capacity, occupies a central position in shaping the region's export strategy. The country's subsoil contains 99 of the 118 elements in the periodic table, including lithium, beryllium, tantalum, and uranium (Zhiyenbayev, 2025). However, the focus on raw exports persists, highlighting the need for a strategic framework that draws on the experiences of resource-oriented economies such as Australia and Chile.

Therefore, the analytical logic of this article combines resource, institutional, and strategic perspectives within a unified theoretical framework.

The study operates on two levels: quantitative assessment and forecasting of export flows encompassing the entire Central Asian region, while the strategic framework is developed specifically for Kazakhstan as the key regional actor. This design enables us to combine regional and national perspectives and formulate applied policy recommendations relevant to neighboring states. It also tests the hypothesis that Kazakhstan serves as the most likely "anchor" node of a regional strategy, with adjacent countries reinforcing it through a functional distribution along the value chain.

The study seeks to develop a strategic framework for Kazakhstan's critical metals and minerals export policy, drawing on international experience, institutional analysis, and the Central Asian context.

To achieve this goal, the study addresses the following objectives:

– to analyze the trends and structure of exports of CMMs in Central Asian countries, identifying imbalances and barriers that hinder deeper processing and integration into global value chains;

– to examine international experience in integrating critical resources into value chains, using examples from Australia, Chile, and other resource-oriented economies, and to identify the institutional conditions that enable them to overcome dependence on raw material specialization;

– to develop a strategic export policy framework for Kazakhstan aimed at sustainable growth, technological modernization, and export diversification.

The practical significance of the study lies in the potential application of the proposed framework in drafting the National Strategy for Critical Metals and Minerals, planning processing clusters, and coordinating interregional initiatives and partnerships with key consumer countries, including the European Union, Japan, and the Republic of Korea. The proposed approach helps balance economic efficiency, technological independence, and environmental sustainability, creating conditions for the long-term integration of Kazakhstan and other Central Asian countries into global value chains.

Theoretical Framework

The global literature on CMMs, especially rare earth elements, shows sustained interest in issues of resource security in the context of technological transformation. CMMs are highly important for the functioning of the modern economy, particularly energy, digital technologies, and defense industry, while having limited possibilities for extraction or processing, which creates risks of supply disruptions (Graedel et al., 2013; Barteková & Kemp, 2016). International organizations and national governments define the list of CMMs according to three criteria: economic significance, supply risk, and lack of available substitutes[5]. In academic literature, they are considered strategic re-

[4] OECD (2024). *Diversifying Kazakhstan's exports: Institutions, policies and infrastructures.* Organisation for Economic Co-operation and Development. Retrieved from: https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/06/diversifying-kazakhstan-s-exports_6db7322e/7f9cd8aa-en.pdf (date of access: 13.05.2025)

5 CRM Alliance. (n. d.). *Critical Raw Materials (CRMs).* Retrieved from: https://www.crmalliance.eu/critical-raw-materials (date of access: 13.05.2025)

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sources that ensure not only economic growth but also technological and national security.

The growing imbalance between global demand for such resources and their limited supply has led to the recognition of CMMs as strategic resources from economic, political, and environmental perspectives (Kooroshy et al., 2015; Gajendra et al., 2025). At the same time, CMMs have become an integral part of the "green" and digital transformation of the global economy. These resources are critical for the production of batteries, electric motors, microelectronics, renewable energy technologies, and other high-tech products (Zhou et al., 2017). CMMs are highly versatile, which gives them cross-sector significance, but their extraction and processing impose serious environmental costs. These environmental consequences pose a significant challenge to sustainable development in the sector. Contemporary research stresses the need to align industrial development with environmental protection, including the integration of Environmental, Social, and Corporate Governance (ESG) principles in mineral resource management (Wan & Wen, 2017; Stern & Valero, 2021; Pommeret et al., 2022). This perspective reflects the concept of a "just transition," which argues that the development of low-carbon technologies must consider the socio-environmental consequences of critical material extraction (Brown et al., 2024). Sustainable CMM management therefore requires increasing production while minimizing environmental harm and complying with international standards for responsible resource use.

Importantly, the global transition to a low-carbon economy does not reduce, but rather sharply increases demand for critical minerals. The spread of electric vehicles, renewable energy, and digital technologies means that more minerals are required per unit of new infrastructure than before. According to the International Energy Agency, in the 2020s, the average amount of mineral resources needed to build a new power generation facility is 50 % higher than in 2010 due to the growing share of renewable energy sources[6]. The World Bank estimates indicate that decarbonizing global energy by 2050 will require about 3 billion tons of various critical materials[7]. This surge in demand makes it necessary to modernize the export policies of resource-supplying countries to avoid vulnerability and supply instability (Mealy & Teytelboym, 2022; Ayres & Peiró, 2013). In other words, states with rich CMM reserves are compelled to develop strategies for integrating into new global supply chains, otherwise they risk remaining mere raw-material appendages in the context of growing competition for resources. Moreover, the dominance of developed countries in controlling technology and final production exacerbates challenges for developing resource economies. Therefore, without improvement in national institutions and policies, it may be difficult to monetize the mineral wealth of such economies.

A substantial body of research is devoted to the institutional conditions for effectively integrating critical resources into global value chains. The experience of several resource-oriented economies shows that strong institutions and proactive industrial policy can enable countries to move beyond raw-material specialization. In Australia and Chile, for example, a clear delineation of the roles of the state and business, government support for deep processing of raw materials, stimulation of R&D, and facilitation of access to international markets have contributed to the creation of more resilient export models (Mealy & Teytelboym, 2022; Cheng et al., 2024). Australia, for instance, has established a transparent regulatory framework and attracted investment in the processing of lithium and rare metals, enabling partial localization of battery and magnet production (Kowalski & Legendre, 2023). Chile, endowed with large reserves of copper and lithium, has strengthened its mining and metallurgical sector through stable fiscal policy (e. g., a copper revenue fund) and partnerships with international corporations, though it continues to strive to increase the share of high value-added exports (Solimano, 2017). In African countries such as Botswana, institutional reforms and agreements with multinational companies (for example, in diamond min-

[6] International Energy Agency (2021). The Role of Critical Minerals in Clean Energy Transitions. Paris: IEA. Retrieved from: https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions (date of access: 13.05.2025)

[7] World Bank. (2020). Minerals for climate action: The mineral intensity of the clean energy transition. Washington, DC: World Bank. Retrieved from: https://commdev.org/publications/minerals-for-climate-action-the-mineral-intensity-of-the-clean-energy-transition/ (date of access: 13.05.2025)

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ing) have helped channel part of the revenues into domestic development and increase processing localization (Acemoglu & Robinson, 2012).

On the contrary, states with institutional rigidity and an unfavorable investment climate show slow progress up the value chain, high dependence on raw-material exports, and a limited processing base (Graedel et al., 2013; Gajendra et al., 2025). For example, many Central African countries remain raw-material suppliers (of cobalt, coltan, etc.) to the global economy with almost no processing involvement, often due to shortcomings in governance and infrastructure (Addison & Roe, 2018). Thus, the institutional factor is recognized as decisive when resource economies attempt to diversify exports: sustainable integration into global value chains requires a predictable regulatory environment, investor rights protection, development of human capital and technology, as well as a coordinated sector development strategy (Auty, 1993; Hausmann et al., 2008).

Despite significant reserves of critical minerals and metals, Central Asian countries remain weakly integrated into the discourse on global resource security. As noted by Vakulchuk and Overland (2021), the region has the potential to become an important supplier of critical minerals for the global green economy, yet the lack of coordinated policy and low levels of local processing significantly limit this potential. Systematic studies of export strategies, investment barriers, and institutional environments in Central Asian countries in relation to the critical minerals sector are virtually absent in international literature. For example, Kazakhstan, Uzbekistan, and Kyrgyzstan possess reserves of lithium, uranium, and rare earth elements, but available data on their integration into global value chains are fragmented (Vakulchuk & Overland, 2021). Nevertheless, amid the global search for new supply sources, interest in Central Asia is increasing, as the region is viewed as a promising yet underexplored contributor to the critical minerals sector.

Early specialized publications on Central Asian countries converge on the view that a shift away from raw-material export specialization towards industrialization and deeper raw-material processing in the region is necessary. An OECD review on Kazakhstan also notes that the continued orientation towards raw-material exports reflects the low competitiveness of the processing sector as well as infrastructural and institutional barriers hindering integration into global value chains[8]. In particular, underdeveloped transport logistics, limited access of SMEs to financing, and incomplete adoption of quality standards impede the export of high value-added products. It is essential to adopt international environmental and social standards to secure Western investment and ensure sustainable supply chains (Stern & Valero, 2021; Tamula et al., 2024). In a similar vein, analysts view the resources of Central Asia as a new field of competition among world powers, emphasizing that only by improving the internal investment climate and governance transparency can countries in the region profitably capitalize on their mineral wealth without becoming dependent on a single party[9].

Confirming these findings, Kuur et al. (2024) conducted an analysis of the level of ESG adoption (environmental, social, and corporate governance principles) in Kazakhstan in light of sustainable development goals. The authors pointed to a decline in the country's rankings in international sustainability indices and highlighted institutional and informational gaps that hinder the advancement of environmentally responsible investments and the disclosure of non-financial reporting according to global standards. Without systemic measures to strengthen ESG infrastructure — from better environmental regulation to greater transparency in mining — Kazakhstan will struggle to move from raw material exports to a sustainable, strategic critical materials policy (Kuur et al., 2024). This conclusion also applies to other Central Asian countries, where environmental and social impacts of extractive projects are becoming increasingly important for international partners and investors.

Despite the emergence of some analytical works and reports, a large part of the literature on Central Asia remains descriptive and does not of-

[8] OECD. (2024). Diversifying Kazakhstan's exports: Institutions, policies and infrastructures. Organisation for Economic Co-operation and Development. Retrieved from: https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/06/diversifying-kazakhstan-s-exports_6db7322e/7f9cd8aa-en.pdf (date of access: 13.05.2025)

[9] Stockholm International Peace Research Institute. (2024). Critical Minerals and Great Power Competition. SIPRI. Retrieved from: https://www.sipri.org/sites/default/files/2024–10/critical_minerals.pdf (date of access: 13.05.20

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fer comprehensive conceptual solutions. There is a clear lack of studies that systematically analyze the institutional conditions for developing export policy and compare regional practices with successful models from resource-driven economies. The absence of such a comparative and comprehensive perspective hinders the development of effective strategies: solutions that proved effective in Australia or Chile have not been adapted and tested in the context of the post-Soviet economies of Central Asia. This gap underscores the need for a comprehensive approach to devising a "new generation" export policy in the critical minerals sector that would combine economic efficiency, institutional reform, and environmental sustainability.

Thus, despite the breadth of available work covering technological, environmental, and certain institutional aspects of critical minerals management, the academic literature reveals a clear shortage of comprehensive studies devoted to the strategic conceptualization of export policy in Central Asian countries. This gap is particularly evident in Kazakhstan, where abundant critical mineral resources have not yet been accompanied by the development of a long-term model for integration into global value chains. This study seeks to fill this gap. Drawing on a comparative analysis of international practices and taking into account regional institutional, economic, and environmental realities, it develops an evidence-based strategic framework for Kazakhstan's export policy (with consideration of other Central Asian states) in the CMM sector. This will lay the groundwork for a transition from a fragmented raw material export model to a sustainable system integrated into the global economy and ensuring a balance between economic benefit, technological modernization, and the principles of sustainable development.

Methods and Data

The study's methodological framework relies on an interdisciplinary approach that combines methods of applied economic analysis, institutional economics, and comparative research.

The work was structured in several stages. The first stage involved analyzing and forecasting the dynamics of mineral raw material exports from Central Asian countries to Europe and Asia using time series analysis methods. The initial data on the value of exports of ores, metals, and precious stones (SITC Rev.4 groups: 27–29, 68–69, 667, 971) for the period 2015–2023 were obtained from the UN Comtrade and ITC Trade Map international databases. To forecast the period 2025–2027, a linear trend model was applied, with parameters estimated using the least squares method. The choice of a linear specification was determined by the stable upward trend in export flows and the absence of pronounced seasonality. The model's adequacy was assessed using the coefficient of determination (R^2) and residual analysis to ensure a statistically reliable forecast of the region's short-term export activity. Even though the model has limitations in data and parameters, it remains adequate for its purpose, providing a scenario-based assessment of key directions for CMM export policy rather than a universal forecast. Such an approach aligns with global research practice, where models are employed as tools for identifying imbalances and testing hypotheses rather than as definitive predictions of trends. The results of this modelling will help establish broad guidelines and highlight institutional factors that require priority attention. The model can be refined and expanded as more data become available; however, even at the current stage, it demonstrates analytical value for developing strategic decisions.

The second stage aimed to identify relevant solutions that have ensured the successful integration of resource-oriented economies into global value chains. To this end, Australia, Chile, and Kazakhstan, differing in their levels of export diversification, were compared. The comparison was conducted across several criteria: the degree of localization of raw material processing; diversification of export markets; investment attraction tools; the institutional framework of state regulation; and the implementation of ESG standards and sustainable development.

Sources of information on institutional models included materials from the OECD, World Bank, UNCTAD, as well as national strategies for industrial and mining development in the respective countries, including the state programs of the Republic of Kazakhstan and analytical reviews by Eurasian Resources Group.

The third stage involved an institutional analysis based on the concepts of new institutional economics. The focus was on assessing the quality of institutions in the areas of subsoil use regulation, licensing, resource property rights allo-

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cation, and state–private sector interaction. This analysis drew on international indices (Worldwide Governance Indicators, Resource Governance Index) and expert interviews that reflected perceptions of barriers to implementing investment projects and the level of institutional integration of Central Asian countries into global rare earth metals markets.

These stages enabled a comprehensive assessment of export policy, combining trade data and institutional analysis to produce strategic recommendations for Central Asia, especially Kazakhstan.

Results

The countries of Central Asia are evolving into major players in the CMM market due to their vast mineral reserves (Huseynov & Sultonazarov, 2024). Figure 1 shows estimated reserves of key minerals in Central Asia, highlighting the region's potential for integration into global strategic supply chains.

These data highlight Central Asia's significant resource potential in the field of CMMs, including rare metals:

1) Manganese ores (38.60 %) — Central Asia, particularly Kazakhstan, holds over one-third of the world's manganese reserves, positioning the region as a key strategic player in global metallurgy, especially in the production of alloyed steels and battery materials.

2) Chromium ores (30.07 %) — Central Asia ranks among the global leaders in chromite reserves, used in metallurgy and the chemical industry. This creates opportunities for advancing local processing and exporting high-tech products.

3) Lead ores (20 %) — Accounting for one-fifth of global reserves, the region plays an important role in supplying raw materials for energy-intensive and engineering industries. Lead is critical for battery and cable manufacturing. Kazakhstan's share of the global lead market is nearly 3 %. In 2021, the country ranked 8th in the world by reserves (2 million tonnes) and 12th by production (40,000 tons). Global annual demand for lead is expected to rise from 11.6 million tons in 2022 to 13.4 million tons by 2031.

4) Zinc ores (12.60 %) — Substantial zinc resources strengthen the region's export potential. Zinc is widely used in construction, automotive manufacturing, and anti-corrosion coatings. Kazakhstan accounts for nearly 5 % of the global zinc market and ranked 7th worldwide in 2023 with reserves of 6.7 million tons. In 2022, 70 % of Kazakhstan's zinc exports went to Turkey, Russia, and China.

5) Titanium ores (8.70 %) — A high-tech strategic metal used in aerospace, medical, and defense industries. The region's reserves provide a strong foundation for developing innovation-driven industrial clusters.

Central Asia and especially Kazakhstan thus possesses vast and diverse reserves of critical metals and minerals that offer significant strategic advantages (Figure 2).

With efficient resource use and advanced processing technologies, the region could establish it-

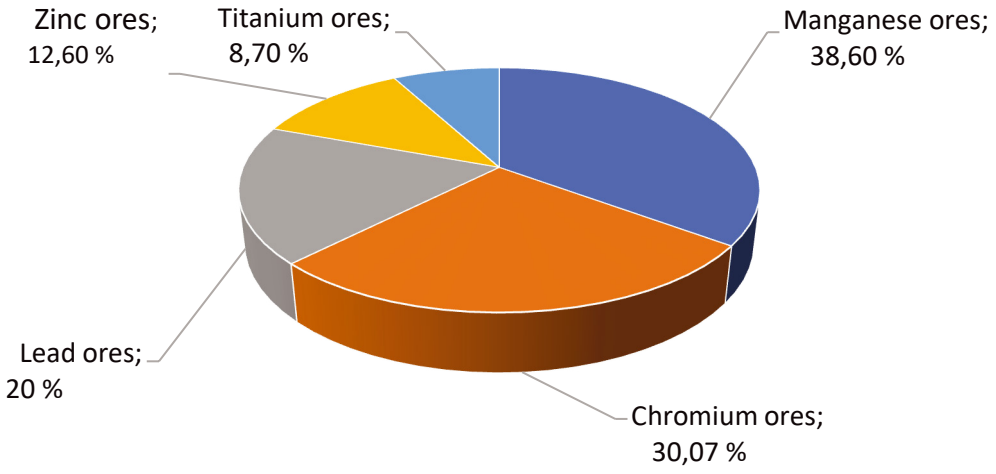

Figure 1. *Share of Central Asian countries in the world reserves of certain types of mineral raw materials (%)*
Source: Guseinov & Sultonazarov (2024)

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Figure 2. *The strategic importance of CMMs for the geoeconomic and technological development of Central Asia*

Source: Compiled by the authors

self as a global leader in CMM production for the green and digital economy.

Kazakhstan has the potential to compete with China, which currently dominates the production of rare earth elements (accounting for 70 % of global output), including metals such as scandium, yttrium, and the 15 lanthanoids. These elements are widely used in the manufacture of computers, turbines, and vehicles. The United States and the European Union are showing strong interest in investing in large-scale mining projects in Kazakhstan, as their heavy dependence on Chinese rare earths has prompted a search for alternative supply sources. These developments show that the issue of critical minerals export has already reached the international level.

Central Asian countries, rich in critical minerals, could be key to global technological progress and the energy transition. Their CMM reserves are seen in the SWOT analysis as a major strength and opportunity provided that internal weaknesses and external risks are addressed (Table 1).

Monazite, zircon, apatite, xenotime, pyrochlore, allanite, and columbite are among the most common rare metals and minerals in Central Asia, found in large volumes in the Kazakh steppe, the Tian Shan mountains, and the Pamirs. The substantial potential for extracting rare earth elements points to promising opportunities for resource development. Even now, minerals and metals account for over 50 % of Kyrgyzstan's exports and more than 30 % for Uzbekistan and Tajikistan, according to the International Energy Agency.

These minerals are vital to modern technology and industry, from electronics and energy to aerospace and agriculture, underscoring their importance for technological advancement and global economic growth.

The export of ores, metals, and precious stones is not dominated by a single country, such as China, but split between two major consumers, although Asia's share is gradually increasing (Figure 3). This rising demand from Asia underscores the need for a targeted export strategy for CMMs to reduce market dependence and fully leverage the region's potential.

To determine the forecast values of the indicators «Export of ores, metals, and precious stones from Central Asia to Europe and Asia, thousand USD» for 2025–2027, a trend model was used.

Initially, the hypothesis of the absence of anomalous observations in the time series was tested. This hypothesis was confirmed using Irwin's criterion.

The approximation of the original data was performed using a first-degree polynomial. The parameters of the chosen growth curve were estimated using the least squares method. As a result, the following trend models were obtained:

— For the export indicator to Europe:

$$y_t = 6\,173\,583{,}57 + 600\,335{,}68t; \quad (1)$$

— For the export indicator to Asia:

$$y_t = 4\,016\,694{,}29 + 1\,149\,075{,}54t. \quad (2)$$

The quality of the resulting models was assessed in two directions: testing adequacy and evaluating model accuracy.

To test model adequacy, the residual series were examined, that is, the differences between the levels calculated by the model and the actual observations. The most important properties of the

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Table 1

SWOT analysis of Central Asian countries' position regarding CMMs

S – significant reserves of CMMs give the region a geo-economic edge; – strategic location between Europe and Asia aids market access; – rising demand for CMMs from countries undergoing the energy transition (EU, China, USA, etc.)	**W** – insufficient processing and technological backwardness: limited raw material processing capacity within the region; – low investment in research and innovation in the mining and processing industries; – dependence on raw material exports rather than creating added value domestically
O – economic development and diversification — investments in mining and processing enterprises can stimulate job creation, infrastructure development, and technology transfer, enhancing overall economic resilience; – strategic partnerships and foreign investment — inflows of capital and expertise can support other economic sectors, improve infrastructure, and build human capital through education and training programs sponsored by foreign partners; – increased strategic importance on the global stage	**T** – seeking to develop their mineral wealth, Central Asian countries may become overly dependent on one or more external powers for economic stability; – environmental degradation (water pollution, soil degradation, and habitat destruction); – socio-economic imbalances — foreign investment inflows and a focus on CMM extraction may worsen inequality in Central Asian countries; – geopolitical competition; – price fluctuations in global raw material markets

Source: Compiled by the authors

residual component are as follows: a mean value equal to zero, randomness of residuals, and conformity to the normal distribution law.

The results of the residual series analysis for model adequacy testing are presented in Tables 2 and 3.

To assess the accuracy of the models, the mean relative approximation error was calculated:

$$E_{rel.} = \frac{1}{n}\sum_{i=1}^{n}\frac{|e_t|}{y_t}\cdot 100\,\% \qquad (3)$$

— For the indicator of exports to Europe: $E_{rel.}$ = 6,38;

— For the indicator of exports to Asia: $E_{rel.}$ = 8,11.

These values indicate a sufficient level of model accuracy. Therefore, the models are of good quality and can be used for forecasting. To calculate the point forecast, the relevant variable values were substituted into the constructed models. For the interval forecast, a confidence interval was determined at a significance level of α = 0,05.

The results of the point and interval forecasts for 2025–2027 are presented in Tables 4 and 5.

The modeling and forecasting results of the examined indicators are presented graphically in Figures 4 and 5.

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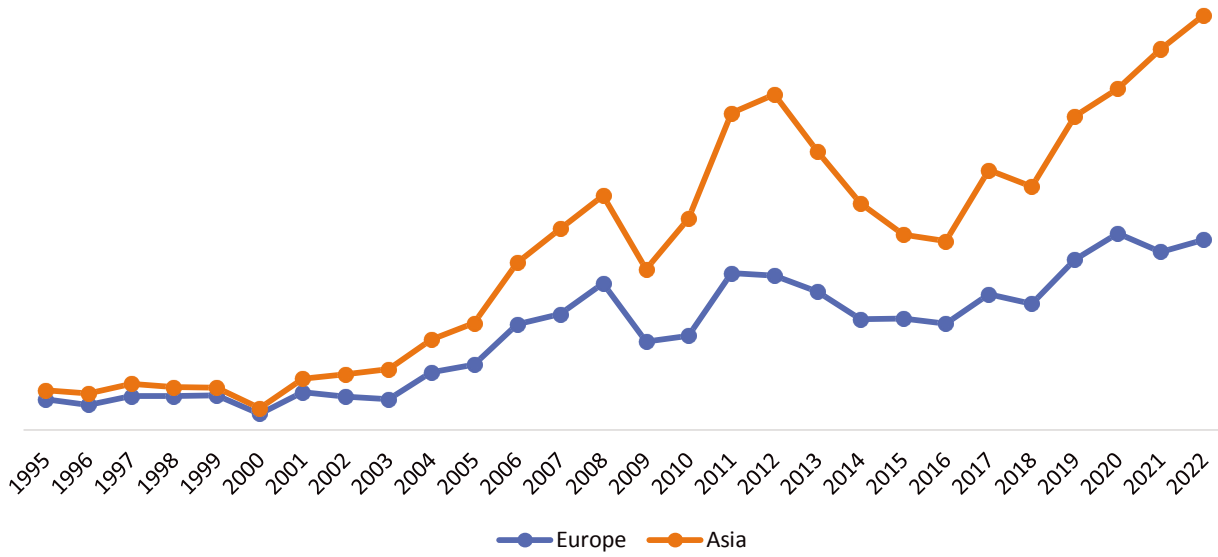

Year	Europe	Asia	Year	Europe	Asia
1995	1524230	448448	2010	4695257	5875797
1996	1245829	584628	2011	7844200	8018874
1997	1697551	617496	2012	7737592	9065874
1998	1711496	448490	2013	6920646	7018178
1999	1718583	394647	2014	5556343	5804768
2000	797297	288738	2015	5567913	4206993
2001	1897074	677675	2016	5310850	4153842
2002	1678623	1105244	2017	6784154	6220330
2003	1540868	1508041	2018	6305547	5873181
2004	2873796	1640208	2019	8533675	7182873
2005	3252805	2114345	2020	9843199	7239856
2006	5280296	3095310	2021	8923897	10150810
2007	5811244	4259455	2022	9519303	11258245
2008	7327809	4420455	2023	10114709	12365680
2009	4429577	3616301	-		

Source: Compiled by the authors

Figure 3. *Export of ores, metals, and precious stones from Central Asia to Europe and Asia (1995–2023), thousand USD*

Source: Guseinov & Sultonazarov (2024)

The calculations and models show high accuracy and reliability, confirmed by acceptable error levels and residual normality. The forecasted export values of ores, metals, and precious stones from Central Asia to both Europe and Asia for 2025–2027 indicate a stable upward trend in the region's foreign economic activity.

The interval forecasts, at a significance level of α = 0.05, cover a wide range, indicating persistent uncertainty linked to global economic and political factors. Nevertheless, they provide a reliable assessment of possible development scenarios. The growth in export indicators, particularly toward Asian markets, highlights the region's increasing importance in in-

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Table 2

Model adequacy test for the indicator of exports to Europe

Tested Property	Statistic Used		Threshold	Conclusion
	Name, calculation formula	Value obtained		
Randomness	"Peaks" criterion (turning points) $p > \left[\frac{2}{3}(n-2) - 1{,}96\sqrt{\frac{16n-29}{90}}\right]$	2 > 1	1	Adequate
Normality	RS criterion $RS = \frac{e_{max} - e_{min}}{S}$	3.17	2,67–3,69	Adequate
Equality of the expected value of residual series levels to zero	Student's t-statistic $t_{obs.} = \frac{\lvert \underline{e} \rvert}{S}\sqrt{n}$	0	2.57	Adequate

Source: Compiled by the authors

Table 3

Model adequacy test for the indicator of exports to Asia

Tested Property	Statistic Used		Threshold	Conclusion
	Name, calculation formula	Value obtained		
Randomness	"Peaks" criterion (turning points) $p > \left[\frac{2}{3}(n-2) - 1{,}96\sqrt{\frac{16n-29}{90}}\right]$	2 > 1	1	Adequate
Normality	RS criterion $RS = \frac{e_{max} - e_{min}}{S}$	3.12	2,67–3,69	Adequate
Equality of the expected value of residual series levels to zero	Student's t-statistic $t_{obs.} = \frac{\lvert \underline{e} \rvert}{S}\sqrt{n}$	0	2.57	Adequate

Source: Compiled by the authors

Table 4

Point and interval forecasts of the indicator «Export of ore, metals, and precious stones from Central Asia to Europe» for 2025–2027

Year	Point forecast, thousand USD	Interval forecast, thousand USD	
		Upper bound	Lower bound
2025	11,576,604.68	6,372,308.79	16,780,900.57
2026	12,176,940.36	6,615,290.10	17,738,590.62
2027	12,777,276.04	6,853,848.63	18,700,703.44

Source: Compiled by the authors

Table 5

Point and interval forecasts for the indicator «Export of ores, metals, and precious stones from Central Asia to Asia» for 2025–2027

Year	Point forecast, thousand USD	Interval forecast, thousand USD	
		Upper bound	Lower bound
2025	14,358,374.11	8,862,086.77	19,854,661.45
2026	15,507,449.64	9,633,758.26	21,381,141.02
2027	16,656,525.18	10,400,758.84	22,912,291.51

Source: Compiled by the authors

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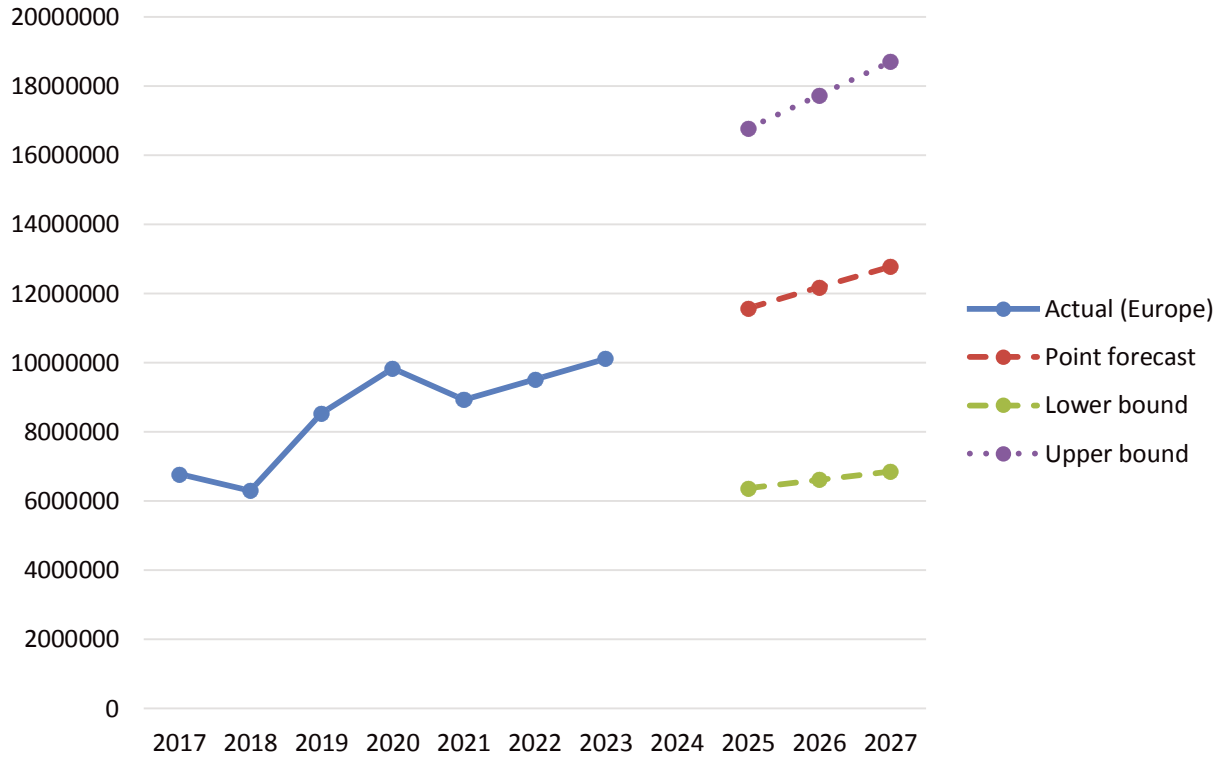

Figure 4. *Point and interval forecasts of "Export of ores, metals, and precious stones from Central Asia to Europe" for 2025–2027, thousand USD*

Source: Compiled by the authors

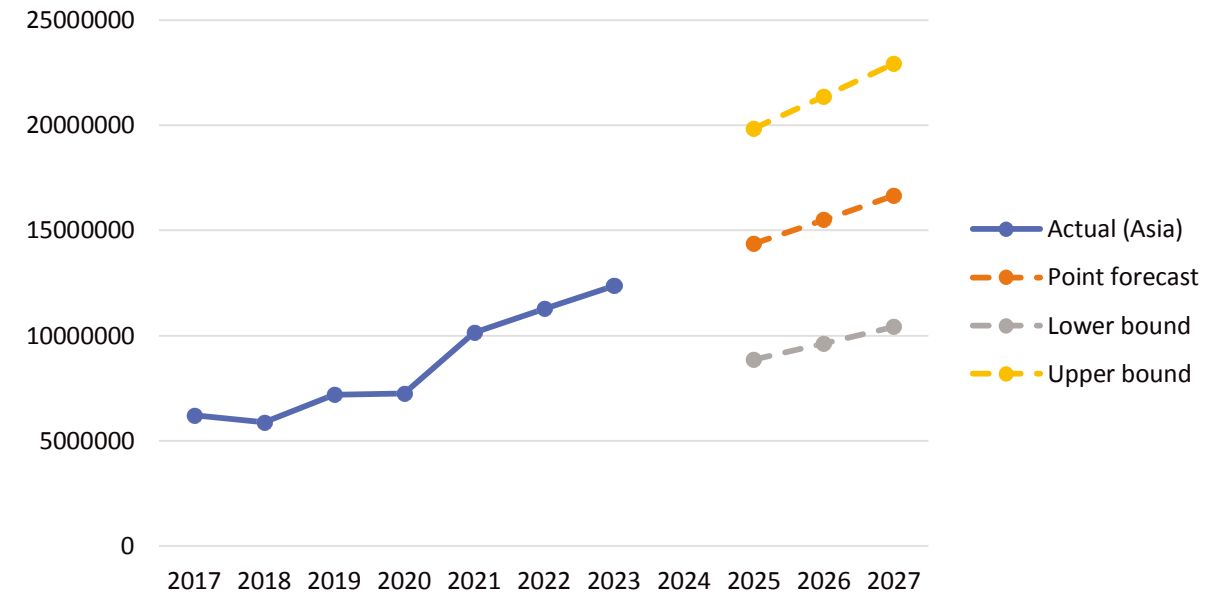

Figure 5. *Point and interval forecasts of the indicator "Export of ores, metals, and precious stones from Central Asia to Asia" for 2025–2027, thousand USD*

Source: Compiled by the authors

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ternational trade in raw materials and reinforces the need for continued modernization of infrastructure, logistics, and export management systems. According to the models, critical metals, whose global demand is rising, are expected to make the largest contribution to this growth.

Our findings can be applied in strategic planning, the design of export programs, investment projects, and the implementation of interregional initiatives within the framework of Eurasian cooperation.

Amid growing global demand for critical resources and rare earth metals, Central Asia faces a dual challenge: on the one hand, the region possesses significant natural potential; on the other, it lacks a unified integration model or a specialized regional structure capable of coordinating export strategies across all Central Asian countries. Despite the existence of organizations such as the EAEU, CSTO, SCO, CIS, and various multilateral dialogue platforms, none serve as a universal mechanism encompassing all Central Asian states or the major Eurasian powers — Russia, China, and India (Table 6).

This increases fragmentation in approaches to managing strategic natural resources and complicates the development of a coordinated export policy grounded in common interest and cooperation. Lessons from resource-rich countries (such as Chile in copper, Australia in lithium and rare earth elements, and Norway in oil and gas) show that a successful resource strategy requires institutional consolidation, a transparent regulatory environment, and export cooperation.

Among Central Asian countries, Kazakhstan possesses world-significant reserves of uranium, chromium, zinc, manganese, copper, and phosphorites. In total, Kazakhstan has 233 mining sites and deposits, of which 151 belong to local companies — some state-owned, others private. The largest is the state company Saryarka (Table 7).

The largest deposits are developed by three corporations jointly owned by local and foreign investors: Eurasian Resources Group (ERG), Kazakhmys Corporation, and KazZinc. The largest of these is ERG, which in 2020 controlled one-third of the country's mining and metallurgical production. ERG is the world's largest producer of high-carbon ferrochrome and one of the largest producers of aluminum, iron ore, copper, and cobalt in the former Soviet Union.

Uzbekistan is rich in deposits of ferrous and non-ferrous metal ores, as well as uranium. Kyrgyzstan's mineral base includes deposits of precious, non-ferrous, rare metals, and non-metallic resources. Tajikistan is rich in uranium deposits, aluminum ores, and polymetallic ores (Table 8).

Many of Central Asia's resource reserves require further exploration and study.

Drawing on their analysis and forecasts, we propose projects in three areas — export programs, investment projects, and interregional initiatives. These proposals are designed as strategic, forecast-based measures built on the following:

1. Results of modeling and forecasts for ore and metal exports for 2025–2027 (point and interval estimates);

2. SWOT analysis of the potential of the Central Asian region;

3. Geoeconomic trends (demand for rare earth elements, diversification of supplies to the EU and Asia, sustainable supply chains),

Table 6

Major regional integration groups and international organizations involving Central Asian countries

Countries		Organizations			
		EAEU	SCO	CSTO	CIS
Central Asia	Kazakhstan	Participant	Participant	Participant	Participant
	Kyrgyzstan				
	Tajikistan	–			
	Turkmenistan		–	–	
	Uzbekistan	Observer	Participant		
	Russia	Participant		Participant	
	China			–	–
	India				

Source: Compiled by the authors

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Table 7

Location of mining companies operating in Central Asia, particularly in Kazakhstan

Legal address/company name	Mineral	Deposit
Kazakhstan		151
Saryarka	Cu, Fe, Mn, Mo, Ni, Co	14
Dzharkulskoye	Fe	5
Arman	Mn	4
Nadezhdinskoye	Fe	3
Tau-Ken Samruk	Cu, Fe, Mo, W	3
Other small local companies	other minerals	122
Multinational		30
Kazakhmys Corporation and KAZ Minerals (Kazakhstan, Singapore, UK)		
Kazakhmys	Cu, Zn	25
KazMinerals Plc Bozshakol	Cu	1
Idygei Project	Cu	1
Itauiz Project	Cu	1
Tamdy-Sainbulak Project	Cu	1
Kazakhmys and Metals of Central Asia	Cu	1
Eurasian Resources Group (ERG) (multinational)		28
TNC “Kazchrome”	Cr, Mn, Si-Mn	11
Aluminium of Kazakhstan	Al, Ga	10
Sokolov-Sarbai Mining and Processing Production Association	Fe	6
Kazakhstan Aluminum Plant	Al	1
Kazzinc (Kazakhstan, Switzerland)		13
KazZinc	Cu, Pb, Zn, Cd, Ag, Se, Te, In	8
Zhairem Mining and Processing Plant (subsidiary of KazZinc)	Cu, Mn	5
Russia	Cu, Zn, Pb	5
China	Fe, Al, Cu	3
Belgium	Te	1
Turkey	Cr	1
UK	Cu	1

Source: U. S. Geological Survey. (2023). Mineral commodity summaries 2023. U. S. Department of the Interior. https://doi.org/10.3133/mcs2023

Table 8

Estimated reserves of major mineral resources in Central Asian countries, %, including critical resources

Resource	Country				
	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Uranium	13.0	less than 0.1	less than 0.1	-	2.0
Copper	~4,0	less than 0.1	less than 0.1	less than 0.1	~0,5
Aluminum (bauxite)	~0,7	less than 0.1	less than 0.1	less than 0.1	~0,2
Rare earth metals	1.0	less than 0.1	0.1	less than 0.1	0.1
Nickel	2	less than 0.1	less than 0.1	less than 0.1	~0,2

Sources: EI Statistical Review (2025). Statistical Review of World Energy. Retrieved from: https://www.energyinst.org/statistical-review (date of access: 15.06.2025); World nuclear association (2025). Uranium Supply. Retrieved from: https://world-nuclear.org/information-library/nuclear-fuel-cycle/uranium-resources/supply-of-uranium. (date of access: 15.06.2025)

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Table 9

Strategic initiatives for CMM export policy, drawn from the research findings

№	Proposal (program)	Objective	Key areas	Description
1	Export program: "Eurasia Metals"	Increasing the volume and added value of raw material exports (ore, non-ferrous and rare earth metals) from Central Asian countries to Europe and Asia	Diversification of the export range	Shifting from raw material exports to exports of semi-finished and finished products (e. g., alloys, cathodes, metal concentrates)
			Development of logistics corridors	Strengthening the Trans-Caspian International Transport Route (TITR) and rail logistics through Kazakhstan, Uzbekistan, and Turkmenistan
			Long-term contracts	Contracts with major Asian and European metallurgical companies with fixed pricing policies and investment commitments
			Digital supply control platform	Implementation of a blockchain- and AI-based traceability and analytics system for export operations
2	Investment project: Rare Metals Valley — Kazakhstan	Creation of an industrial technopark and cluster for processing rare earth and non-ferrous metals in central Kazakhstan	Creation of a next-generation metallurgical complex	Purification, refining, alloying, and packaging
				Engineering center and laboratories for applied R&D in metal extraction, utilization, and recycling technologies
				Training center: professional courses in rare earth metallurgy, chemistry, logistics management, and export
			Investment volume	~$250 million (of which 30 % are private, 30 % are international, and 40 % are government subsidies)
3	Interregional initiative: Eurasian Mineral Alliance (EMA)	Coordination of extraction, processing, and export policies for critical minerals among Central Asian countries, the EAEU, and partners from the EU, China, and South Korea	Creation of a common regulatory framework	Standards for environmental, social, and technological responsibility (ESG)
			Joint forecasting and regulation of exports	Introduction of a quota system and priority markets
			Creation of the Eurasian Sustainable Mineral Supply Fund	Infrastructure support, financing of strategic projects
			Technology exchange	Creation of an exchange platform between scientific institutions, business and the government in the field of "green metallurgy"
			Establishment of an annual EMA Forum	Discussion of macroeconomic, trade, logistics and ESG issues

Source: Compiled by the authors

4. Sustainable Development Goals (SDGs) and strategies for industrial cooperation within the framework of the EAEU and SCO (Table 9)

Expected results from implementing these programs include the following: a 20–25 % increase in metal exports to the EU and Asia by 2030; GDP growth in participating countries through industrialization and adoption of digital solutions; geoeconomic strengthening of Central Asia's position as a key raw-material hub; and increased employment and skill levels among local workforces.

Kazakhstan can ensure uninterrupted supply of CMMs and help meet growing global demand driven by the energy transition and the expansion of the electric vehicle market. Kazakhstan has export potential in nine product groups, including critical metals it already exports and others with untapped potential, most notably lithium, nickel, and rare earth metals. Kazakhstan has demon-

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Table 10

Investment projects

	Investment project	Investor's country	Region	Cost, million dollars
A	Construction of a mining and beneficiation plant for lithium extraction and processing	Germany	East Kazakhstan	470
B	Processing of pegmatite ores to produce lithium oxide concentrate (Asubulak pegmatite deposit)	Germany	East Kazakhstan	180

Source: AIFC Authority (2024). Reserves of critically important raw materials allow Kazakhstan to become a leading supplier in the context of the energy transition. Retrieved from: https://aifc.kz/ru/novosti/zapasy-kriticheski-vazhnogo-syrya-pozvolyayut-kazahstanu-stat-vedushhim-postavshhikom-v-ramkah-energeticheskogo-perehoda/ (date of access: 06/15/2025)

strated comparative advantages in the global market for copper, zinc, aluminum, silver, and lead. Rare earth metals are seen as potential resources for emerging exports that could give Kazakhstan a competitive edge in the world market.

Kazakhstan accounts for nearly 4% of the global copper market. In 2023, it ranked 11th in the world in copper reserves with 20 million tons. In 2022, Kazakhstan's top three copper export destinations were China, Turkey, and the UAE.

Kazakhstan's share of the global aluminum market is less than 1%. In 2023, it ranked 11th worldwide in bauxite reserves (160 million tons) and 10th in bauxite production (4.3 million tons). In 2022, the top three export destinations for Kazakh aluminum were Turkey, Italy, and Greece.

Metals with export potential that remain underdeveloped include the following:

1. Nickel — Kazakhstan is among the world's top 20 countries in nickel reserves, holding about 1.5 million tons, or 2% of global reserves. However, current global demand is low. Annual global demand for nickel is expected to rise from the current 3 million tons to between 3.9 and 5.8 million tons by 2030, and to between 4.8 and 6.5 million tons by 2050.

2. Lithium — Kazakhstan's geological services already cooperate with companies from Germany, South Korea, and the UK on exploration and development of lithium deposits in East Kazakhstan. In March 2024, the Korean Institute of Geological-Geophysical Research and Mineral Resources discovered a new lithium deposit in East Kazakhstan with a 5.3% lithium content, valued at about $15.7 billion. Kazakhstan's lithium deposits are concentrated in Yubileynoye, Verkhne-Baymurzinskoye, Bakennoye, Akhmetkino, Medved-

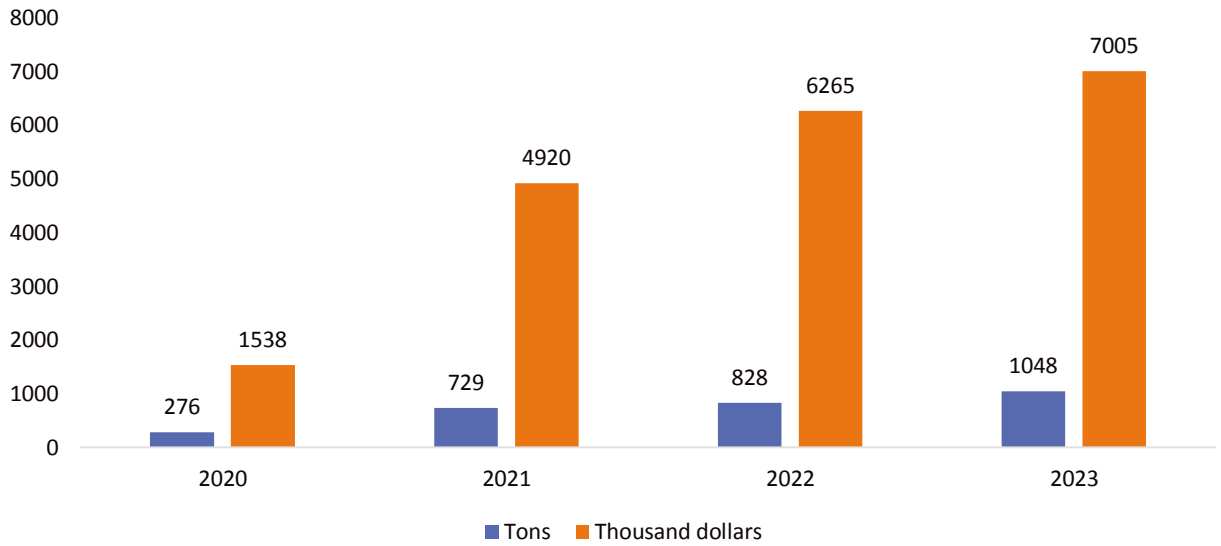

Figure 6. *Dynamics of Kazakhstan's CMM exports (HS codes 280530 and 284690)*

Source: Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, https://stat.gov.kz/(date of access: 15.06.2025)

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ka, and Akhmirovskoye. Currently, Kazakhstan's lithium reserves and projects are concentrated in East Kazakhstan Region (Table 10).

Since 2020, Kazakhstan's export of rare and rare-earth metals has increased 4.6 times in dollar terms and 3.8 times in real terms. In December 2023, Kazakhstan adopted the Comprehensive Development Plan for the Rare and Rare-Earth Metals Industry for 2024–2028, under which it plans to invest 2.4 billion tenge (~$5.3 million) over the next five years in developing rare metals and RRM mining. In May 2024, the Senate of Kazakhstan stated that the country's potential resources of rare metals and RRM could include around 5,000 deposits worth $46 trillion. The dynamics of Kazakhstan's exports of rare earth metals (HS codes 280530 and 284690) are shown in Figure 6.

Since 2005, about 16.4% (USD 67 billion) of Kazakhstan's total foreign direct investment has gone to the metallurgical industry, including critical minerals. Developing a strategic export policy for the CMM sector — drawing on the experiences of resource-oriented countries such as Australia and Chile — helps Kazakhstan set priorities, tackle structural challenges, and transition toward processing, sustainability, and ESG-focused investment.

A comparative analysis of resource-oriented economies such as Australia, Chile, and Ka-

Table 11

Analysis by criteria, justification of the strategic framework

Criterion	Kazakhstan	Australia	Chile	Lessons and strategic goals for Kazakhstan
Type of resources and scale of extraction	Extensive but underutilized potential for rare earth metals, uranium, and lithium	Leader in lithium extraction, rare earth metals (Mount Weld)	Lithium, copper, but not rare earth metals	Inventory and digitize its CMM resources, based on geological exploration and modeling of promising deposits, including rare metals in tailings
Export strategy focus	Raw material export, partial shift to processing	Balanced model: raw materials + processing	Export of raw materials mainly serving the interests of TNCs	Shift from a raw-material model to a value-added model by investing in domestic processing capacity
Added value (localization)	Low	Medium	Low	Implement government incentives and tax benefits for enterprises processing CMMs in Kazakhstan
Foreign investment	Attracting investment from Russia and China	Diversified portfolio (EU, USA, Japan)	Limited market	Diversify investment sources by forming partnerships with ESG-oriented countries and funds
Sustainable development policy (ESG)	Initial stage of implementation	ESG standards, especially regarding water use and biodiversity	Strong environmental oversight	Integrate ESG criteria into licensing, certification, and export contracts
Government regulation	State monopolies, licensing, low transparency	Transparency, auctions, international standards	State monopolies, partially closed processes	Introduce transparent tender mechanisms to encourage SME participation and implement digital resource management
Economic diversification	Low	High	Moderate	Link CMM exports to the creation of a cluster for producing "green technologies," including hydrogen energy, batteries, and electronics
Logistics	Good, Trans-Caspian route	Developed ports and railways	Good (copper — via northern ports)	Modernize logistics with a focus on multimodal export corridors through the Caspian, especially to the EU
Problems and challenges	eco-protests, raw material dependency	Competition with China, pressure on the environment	Resource curse, social conflicts	Proactively engage with local communities and environmental NGOs by introducing corporate social responsibility commitments

Source: Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan https://stat.gov.kz/

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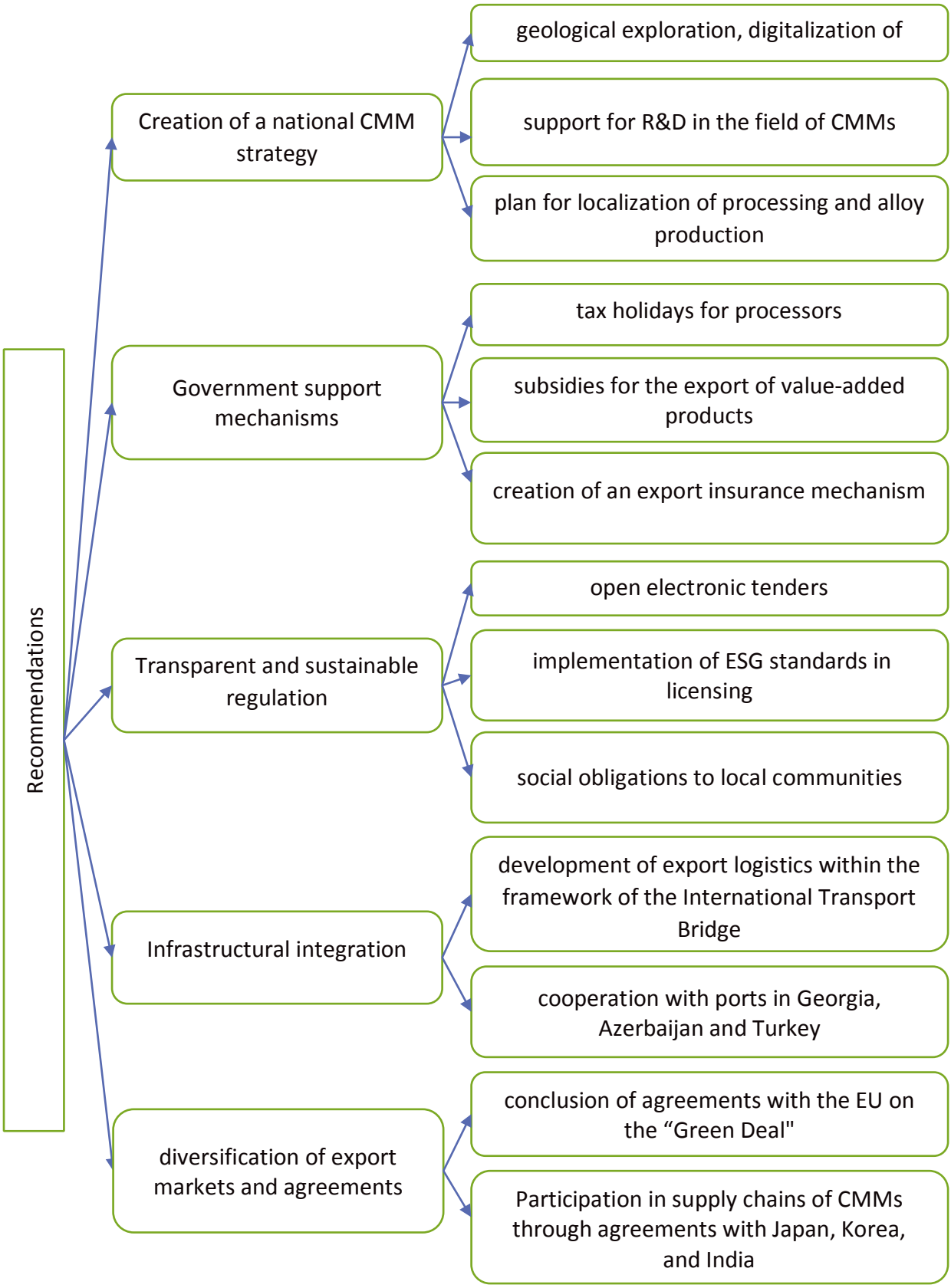

Figure 7. *Recommendations for the strategic framework*

Source: Compiled by the authors

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Table 12

Analytical rationale for Kazakhstan's CMM export policy priorities

№	Priority	Analysis	Application
1	Balance between raw-material exports and processing localization	Kazakhstan possesses large reserves of CMMs, including uranium and lithium. In global practice: Australia develops processing with participation from the EU and Japan, while Chile maintains a raw-material orientation. Kazakhstan would benefit from a mixed approach.	Diversified exports, reduced price vulnerability, increased employment, and enhanced technological capacity
2	Reducing dependence on a single market	China is the largest importer and processor of rare earth metals. Australia's experience shows the effectiveness of diversification through alliances (USA, EU, Japan) and new transport routes. Kazakhstan could leverage the Trans-Caspian transport corridor.	Expanded export geography, reduced geo-economic risks, strengthened bargaining position
3	Institutional resource management	State companies ("Kazatomprom") play a large role in Kazakhstan. Chile ensures transparency in state support, while Australia promotes open competition and partnerships. Kazakhstan needs to reform its regulatory environment.	Increased investment attractiveness, inflow of private capital, improved risk management, and sustainable sector development

Source: Compiled by the authors

zakhstan supports the development of a strategic framework for export policy in the CMM sector, outlining key priorities and important lessons for Kazakhstan (Table 11).

Kazakhstan has a unique potential to develop a national export strategy for CMMs, drawing on the best practices of leading countries. However, it is important to avoid the pitfalls of resource dependence and to strengthen domestic processing, sustainability, and transparency (Figure 7).

Australia's experience shows that institutional maturity and an ESG-oriented policy not only attract investment but also retain technology. In the short term, Kazakhstan needs to develop an export-industrial roadmap linked to global value chains in the field of CMMs (Table 12).

For Kazakhstan to successfully implement its export policy in the CMM sector, it is essential to strengthen its domestic processing capacities, reduce dependence on a single export market (such as China), and modernize the institutional framework for resource management. This modernization should involve building strategic partnerships, enhancing infrastructure cooperation, and developing a smart, forward-looking approach to resource diplomacy. Kazakhstan should also strengthen institutional mechanisms that ensure transparency in licensing and land allocation, protect investors (including through reforms in arbitration and state guarantees), integrate ESG principles into project evaluations, and improve coordination between central and regional authorities.

Conclusion

This study proposes an evidence-based strategic framework for Kazakhstan's CMM export policy, considering international experience and regional specificities. The framework builds on three key steps. First, an analysis of current trends and export structures in Kazakhstan and other Central Asian countries identified the sector's main imbalances and bottlenecks. Second, a comparative study of resource-oriented economies, including Australia and Chile, highlighted institutional conditions that support a shift from raw-material dependence. Third, these findings informed the development of a strategic export policy framework with clear priorities and project proposals targeting sustainable growth, technological modernization, and export diversification.

The research revealed significant institutional obstacles constraining the development of the sector. Despite substantial CMM reserves, Kazakhstan's exports remain largely resource-oriented, with limited processing and a strong dependence on a single external market — China. A weak regulatory environment and insufficient coordination limit investment inflows and local value-added production, increasing the sector's vulnerability to external shocks. These institutional findings highlight the need for structural reforms to deepen processing and reduce export dependence.

In response to these challenges, the study proposes a "next-generation export strategy" built around three key priorities: gradual localization

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of raw material processing and an increase in the value-added share of production; reducing export dependence through the development of Trans-Caspian logistics and the establishment of partnerships with alternative importers (the EU, Japan, and the Republic of Korea); institutional modernization, including greater transparency in licensing, the adoption of ESG standards, and the promotion of private investment in the sector. The proposed project initiatives are designed to support the practical implementation of this strategy by fostering the creation of processing clusters and strengthening international cooperation in the CMM sphere.

The findings confirm the strategic importance of CMMs for Kazakhstan's successful green transition, technological sovereignty, and long-term sustainable economic growth. Comprehensive implementation of the proposed measures would accelerate the country's industrial and innovative development and strengthen its position in global value chains for critical resources. Kazakhstan has the potential to become a central hub in strategic CMM supply chains, provided that institutional consolidation and the execution of a next-generation export policy are ensured.

A limitation of the study lies in the absence of dynamic scenario evaluation under conditions of external instability, as well as the reliance on secondary data and expert assessments in the institutional analysis. Future research should focus on developing quantitative models to assess the impact of export policy on GDP structure and employment, along with a deeper examination of regional coordination mechanisms among Central Asian countries in the CMM domain.

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